Social Network Analysis of Crowds

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Distribution Statement A

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14. ABSTRACT

We will present findings from our ongoing experimentation using the Crowd Behavior Testbed. The work falls under the presentation topic area of "understanding human behavior" and "social network analysis." For the last two years, the Target Behavioral Response Laboratory has conducted laboratory research on crowd behavior in response to simulated non-lethal weapons. Data and results from this testing will be presented. Subjects participated in an experiment investigating crowd behavior and response to a control force. During the entire time that subjects were participating, crowd behavior and interactions were videotaped. Videotape recordings of interactions during engagements with control force and informal interactions between crowd members were coded for inter-member interactions. These social communications and interactions were subjected to social network analysis to identify leaders and other influential crowd members, hubs, isolates, dyads, triads, and clusters of nodes (individuals). Two other sources of data were analyzed using network analysis. Before the study, subjects identified the individuals they had known before the test. After the main crowd-control force experiment, subjects also identified those they thought acted as leaders or were highly capable of influencing the crowd. Social network analysis was then conducted to identify patterns of pre-existing social bonds as well as to identify informally nominated leaders in the group. Procedures to characterize crowds based on social network analysis methods will be presented. The presentation will conclude with a discussion on applications to crowd behavior modeling.

15. SUBJECT TERMS

crowd, non-lethal weapon, social network analysis, sociometrics, social bonds, social interaction, leader nominations, crowd experimentation

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- Crowd situations are one of the premier situation in which to utilize non-lethal weapons and systems
- Lack of data on crowd responses to non-lethal weapons
- Several attempts at Crowd Modeling and Simulation (based on the claims of difficulty and costs associated with experimentation on human crowds)
- Models and Simulations need to be based on real data, otherwise they are fiction

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RDECOM

- Group of 19 individuals
- Halt Approach Scenario ("Deny access into/out of an area to individuals" JNLE/CBA)
- Video recording of crowd-control force interaction
- Simulated stand-off weapon
- Self-Report Questionnaires

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Indoor Crowd Behavior Testbed Layout

Video Cameras on Trusses

- Response to non-lethal weapons fire depends on social relationships among crowd members
  - Pre-existing Personal Relationships
  - Ongoing Real Time Social Interactions
  - Formal/Informal Hierarchies

- Therefore need method to assess social factors
- Social Network Analysis

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▸ **Social Bonds**

    ▸ Self-Report

▸ **Crowd Social Interactions**

    ▸ Observed on Video

▸ **Leader Nomination**

    ▸ Questionnaire

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- 19 x 19 matrix submitted to networking analysis software
- ORA Version 1.9.5.4.3, Dr. Kathleen M. Carley, Center for Computational Analysis of Social and Organizational Systems (CASOS), Institute for Software Research International (ISRI) School of Computer Science (SCS) Carnegie Mellon University
- Visualization for insight
- Numerical Sociometrics outputted for formal analyses: density, isolates, linkages among nodes

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Do you know anyone else who is participating in the study today?

Yes   No

If yes, please indicate who you know based on the subject number assigned to them (on their tee shirt or folder). Please circle their numbers below:
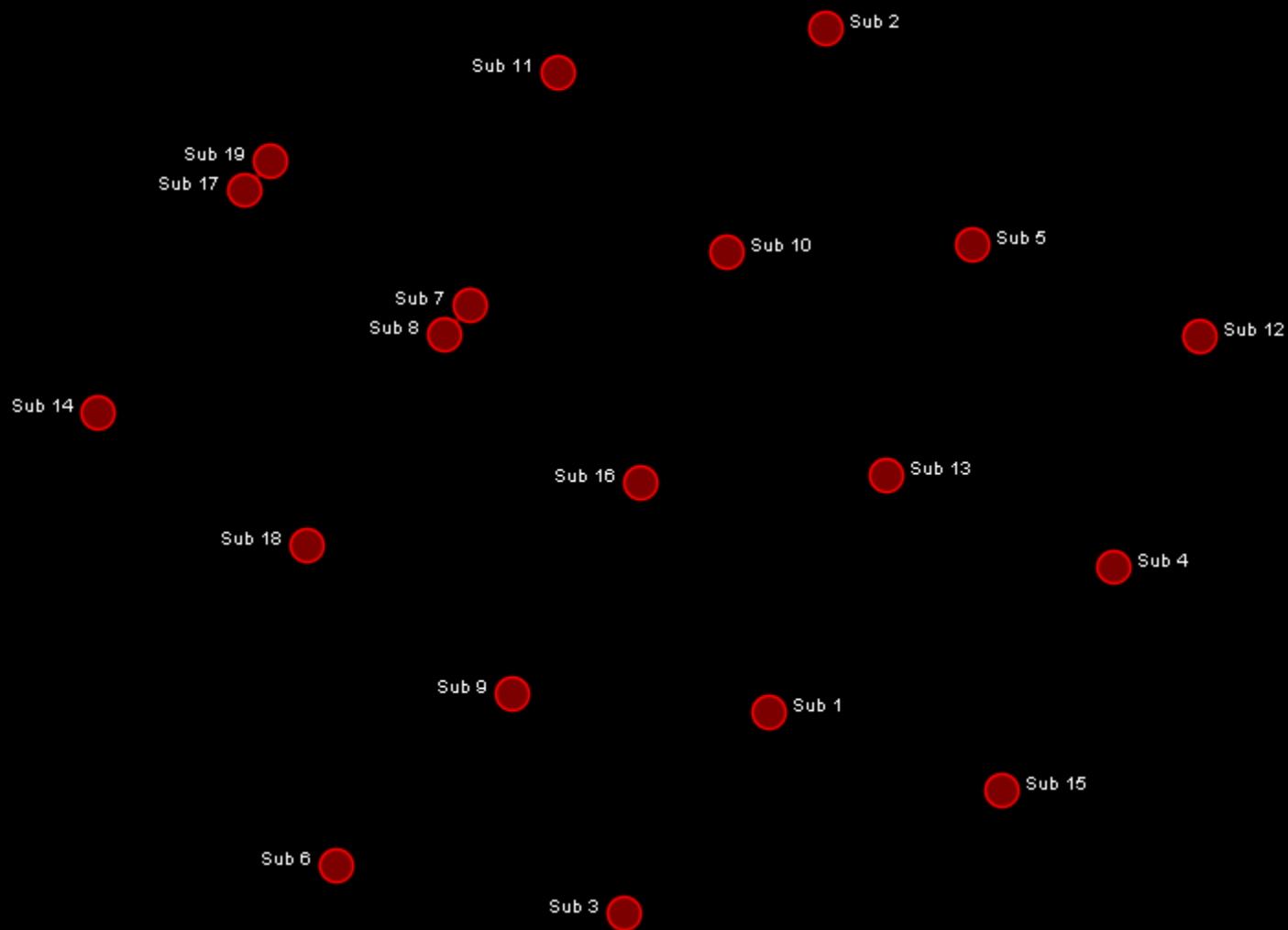
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

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Pre-existing Social Bonds

- Videotapes coded for pair-wise social interaction among crowd members:

  - Verbal communication, physical contact, gestures, non-verbal auditory signaling

  - Scored three 2-minute epochs before/during crowd-control force interaction

  - Inter-rater reliability .94

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	Sub 1	Sub 2	Sub 3	Sub 4	Sub 5	Sub 6	Sub 7	Sub
Sub 1	0	0	0	0	0	1	0	
Sub 2	0	0	0	0	0	0	0	
Sub 3	0	0	0	0	0	0	0	
Sub 4	0	0	0	0	0	0	0	
Sub 5	0	0	0	0	0	0	0	
Sub 6	1	0	0	0	0	0	0	
Sub 7	0	0	0	0	0	0	0	
Sub 8	0	0	0	0	0	0	1	
Sub 9	0	1	1	0	0	0	0	
Sub 10	0	0	0	0	0	0	0	
Sub 11	0	0	0	0	0	0	1	
Sub 12	0	0	0	0	0	0	0	
Sub 13	0	0	0	0	0	0	0	
Sub 14	0	0	0	0	0	0	0	
Sub 15	0	0	0	0	0	0	0	
Sub 16	0	0	0	0	0	0	0	
Sub 17	0	0	0	0	0	0	0	
Sub 18	0	0	0	0	0	0	0	
Sub 19	0	0	0	0	0	0	0	
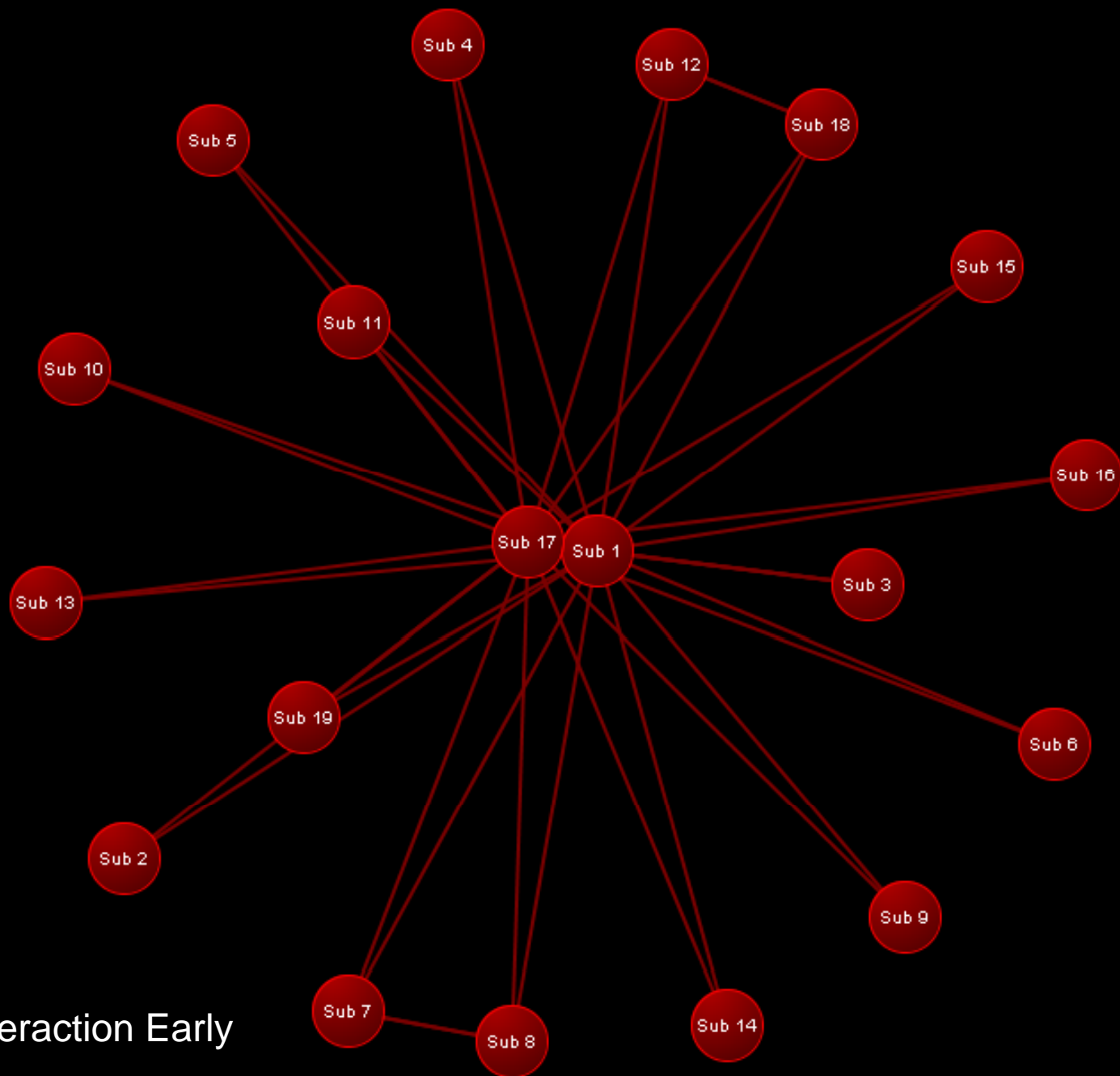
Social Interaction Early

Social Interaction Middle
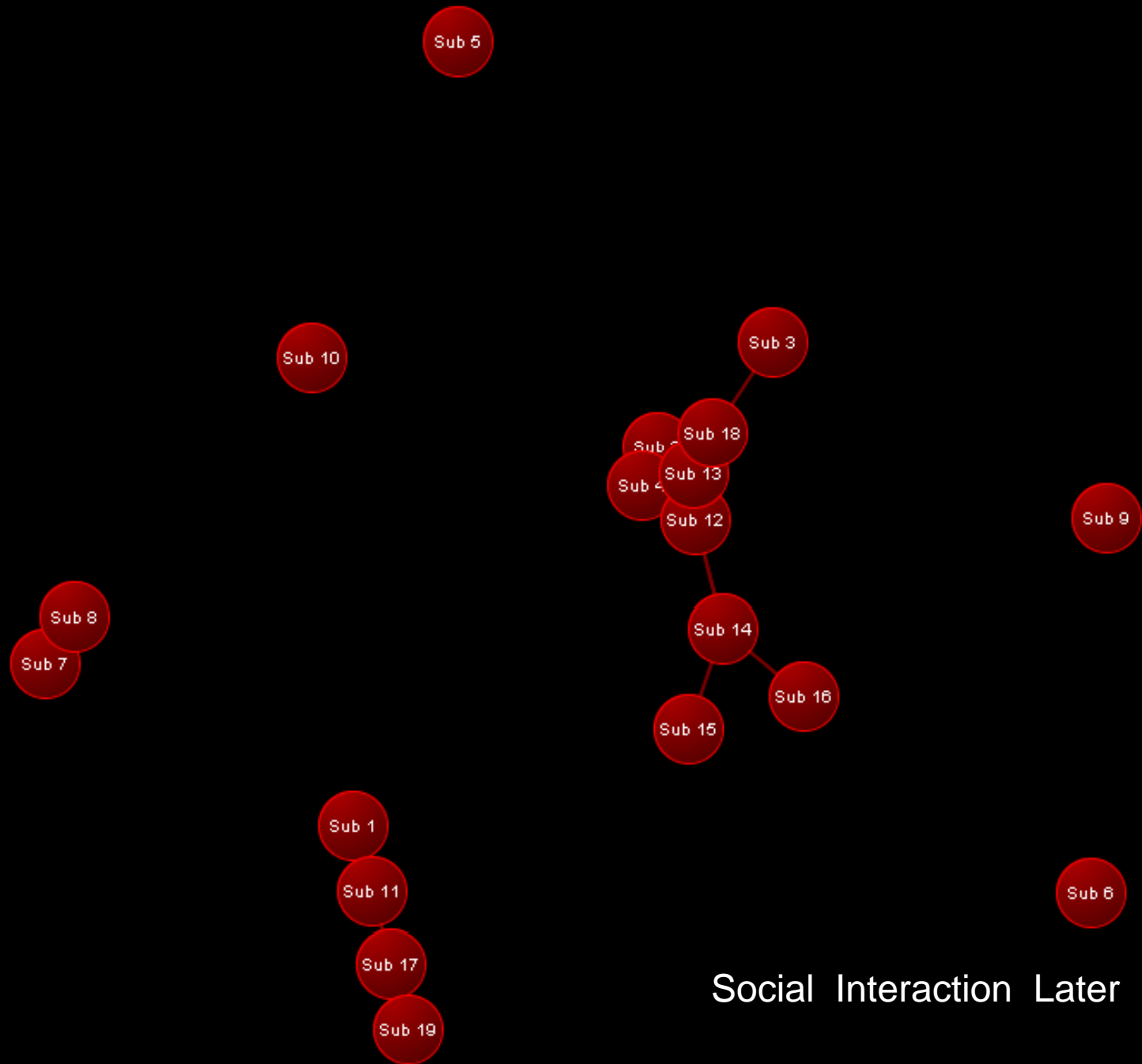
Social Interaction Later

Was there a person (or people) in your group that you considered to be a leader (or leaders)?

Yes   No

If yes, please indicate all the people that you thought were leaders.

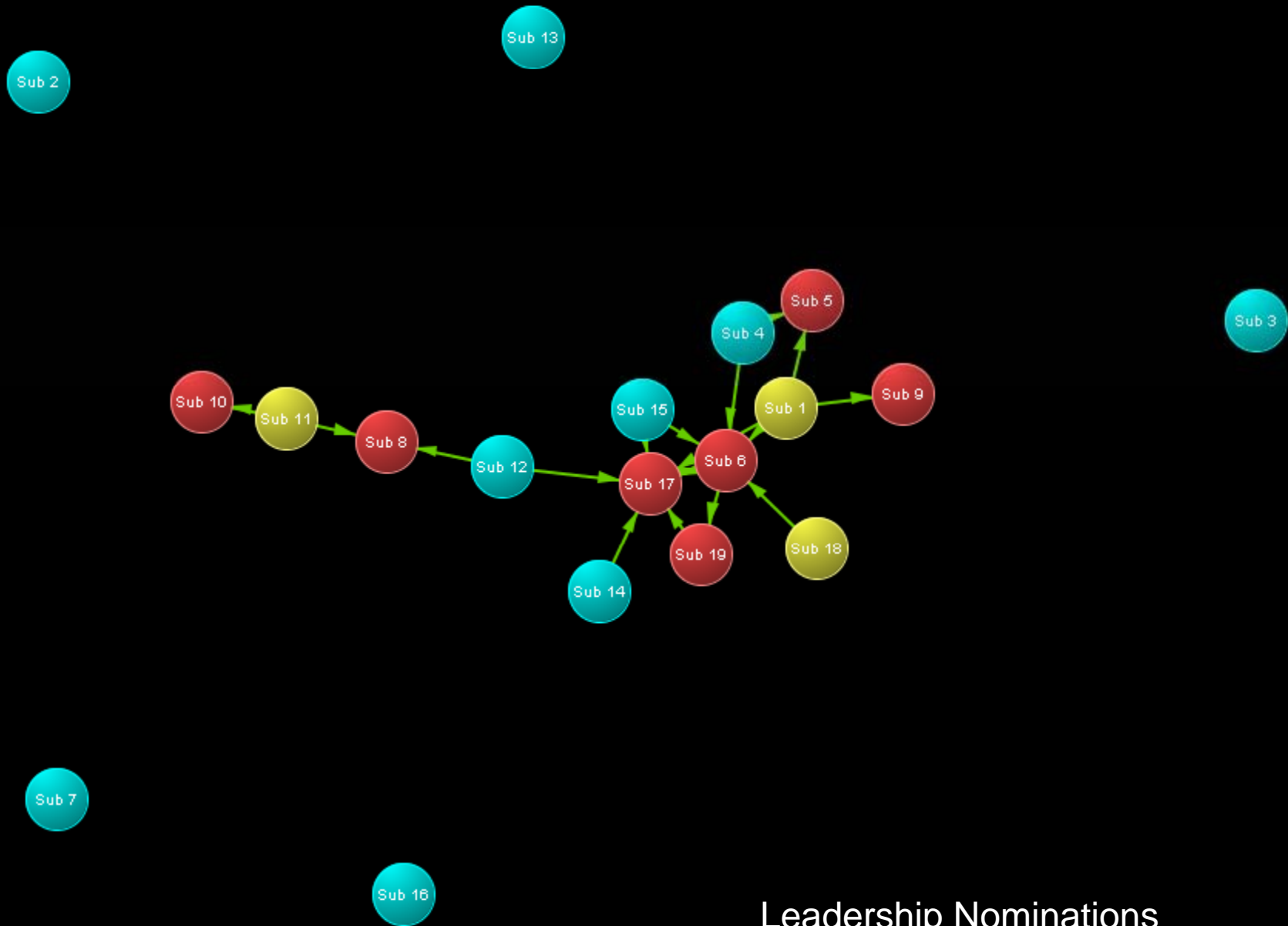Please circle their numbers below:

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

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Leadership Nominations

	Social Bonds	Early Interactions	Late Interactions	Leadership
Node Count	19	19	19	19
Density	0.0117	0.1257	0.0936	0.0526
Fragmentation	0.9883	0	0.7485	0.4678
Isolate Count	15	0	4	5
Link Count	4	43	32	18
Centralization	0.049	0.5114	0.2059	0.1585

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- Ongoing experimentation
- Network analyses yield quantitative methods for crowd psychosocial characterization
- Can be used to examine questions of social factors that moderate crowd responses to non-lethal weapons and systems
  - Prior, existing social relationships
  - Real time social interactions
  - Formal/informal hierarchies

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- Use data from laboratory crowd experiments as input into modeling and simulation investigations
  - Creation of algorithms
  - Validation/Verification
  - Mission Analysis
  - Training
- In conjunction with results from experiments of behavioral measures

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QUESTIONS?

- Thu 6 Aug 2:30-2:55 PM   Madison
- **"Results from Experimentation on Driver Behavior at Controlled Entry Points"**

- Thu 6 Aug 5:00-5:25 PM   Grand Dominion 3
- **"Empirical data sets for agent based modeling of crowd scenarios"**

- Thu 6 Aug 4:00-4:25 PM Grand Dominion 4
- **"Data Sources for Human Behavior"**

- Thu 6 Aug 5:00-5:25 PM Grand Dominion 4
- **"Subject Matter Experts from Academia"**

- Network science and crowd behavior metrics. Proceedings of the 26th Army Science Conference, December 1-4, Orlando, Florida.

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Gather <u>empirical data</u> on <u>real human behavior</u> in response to non-lethal weapons and systems with real people in tactically relevant situations

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